What is claimed is:

1. An ethylene copolymer which is a copolymer (A-1) of ethylene and an α-olefin of 3 to 20 carbon atoms and has the following properties:

(a) the melt index (MI2) at 190°C under a load of 2.16 kg is in the range of 0.0001 to 1000 g/10 min,

(b) the density is not more than 0.899 g/cm^3,

(c) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (c),

and

(d) the relationship between a vinylidene group amount and MI2 of the polymer satisfies the following expression (d):

(vinylidene group amount: number of vinylidene groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (d).

2. The ethylene copolymer as claimed in claim 1, wherein the ethylene copolymer (A-1) further has the following properties:

(C-1) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c-1):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) ≤ 0.004509+0.000815×log(MI2) (c-1),

and

(D-1) the relationship between a vinylidene group amount and MI2 of the polymer satisfies the following expression (d-1):

(vinylidene group amount: number of vinylidene groups/1000 carbon atoms) ≤ 0.013528+0.002445×log(MI2) (d-1).

3. An ethylene copolymer which is a copolymer (A-2) of ethylene and an α-olefin of 3 to 20 carbon atoms and has the following properties:

(a) the melt index (MI2) at 190°C under a load of 2.16 kg is in the range of 0.0001 to 1000 g/10 min,

(b) the density is in the range of 0.875 to 0.899 g/cm^3, and

(c) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (c).

4. The ethylene copolymer as claimed in claim 3, wherein the ethylene copolymer (A-2) further has the following properties:

(C-1) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c-1):

(vinyl group amount; number of vinyl groups/1000 carbon atoms) ≤ 0.004509+0.000815×log(MI2) (c-1).

5. An ethylene copolymer which is a copolymer (A-3) of ethylene, an α-olefin of 3 to 20 carbon atoms and a cycloolefin and has the following properties:

(a) the cycloolefin content is not less than 0.01 % by mol,

(b) the melt index (MI2) at 190°C under a load of 2.16 kg is in the range of 0.0001 to 1000 g/10 min,

(c) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (c),

and

(d) the relationship between a vinylidene group amount and MI2 of the polymer satisfies the following expression (d):

(vinylidene group amount: number of vinylidene groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (d).

6. The ethylene copolymer as claimed in claim 5, wherein the ethylene copolymer (A-3) further has the following properties:

(c-1) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c-1):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) $\leq 0.004509+0.000815\times\log(MI2)$ (c-1),

and

(d-1) the relationship between a vinylidene group amount and MI2 of the polymer satisfies the following expression (d-1):

(vinylidene group amount: number of vinylidene groups/1000 carbon atoms) $\leq 0.013528+0.002445\times\log(MI2)$ (d-1).

7. The ethylene copolymer as claimed in any one of claims 1 to 6, wherein regio-regularity of the α-olefin of 3 to 20 carbon atoms, as measured by ^{13}C-NMR, satisfies the following expression (e-1):

$T\alpha\beta/(T\alpha\beta+T\alpha\alpha) \leq 0.25-0.0020\times x$ (e-1)

wherein Tαβ is a peak intensity of a carbon atom having branches at the α-position and the β-position in the ^{13}C-NMR spectrum, Tαα is a peak intensity of a carbon atom having branches at both of the α-positions, and x is an ethylene content (% by mol) in the polymer.

8. The ethylene copolymer as claimed in any one of claims 1 to 7, wherein regio-regularity of the α-olefin of 3 to 20 carbon atoms, as measured by ^{13}C-NMR, satisfies the following expression (e-2):

$$T\beta\gamma/(T\beta\gamma+T\beta\beta) \leq 0.30-0.0015\times x \quad (e-2)$$

wherein $T\beta\gamma$ is a peak intensity of a carbon atom having branches at the β-position and the γ-position in the ^{13}C-NMR spectrum, $T\beta\beta$ is a peak intensity of a carbon atom having branches at both of the β-positions, and x is an ethylene content (% by mol) in the polymer.

9. The ethylene copolymer as claimed in any one of claims 1 to 8, wherein the molecular weight distribution (Mw/Mn), as measured by GPC, is in the range of 1.2 to 10.

10. The ethylene copolymer as claimed in any one of claims 1 to 8, wherein the molecular weight distribution (Mw/Mn), as measured by GPC, is in the range of 1.6 to 10.

11. The ethylene copolymer as claimed in any one of claims 1 to 10, which satisfies the relational expression MI10/MI2 < (Mw/Mn)+5.55.

12. The ethylene copolymer as claimed in any one of claims 1 to 11, which satisfies the relational expression $MI2 > 19.009 \times (\eta)^{-5.2486}$.

13. The ethylene copolymer as claimed in any one of claims 1 to 12, wherein the ash content in the ethylene copolymer is not more than 1000 ppm.

14. The ethylene copolymer as claimed in any one of claims 1 to 13, wherein the titanium element content in the ethylene copolymer is not more than 10 ppm, and/or the zirconium element content in the ethylene copolymer is not more than 10 ppm.

15. The ethylene copolymer as claimed in any one of claims 1 to 14, which is a copolymer prepared without contact of the reaction solution with water and/or an alcohol in an amount of not less than 1/10 of the weight of the copolymer in a solution state or a semi-precipitation state.

16. The ethylene copolymer as claimed in any one of claims 1 to 15, which is a copolymer prepared by forming not less than 50 % of chain transfer by the addition of hydrogen.

17. A molded product comprising the ethylene copolymer of any one of claims 1 to 16.

18. A resin modifier comprising the ethylene copolymer of any one of claims 1 to 16.

19. A composition comprising the ethylene copolymer of any one of claims 1 to 16 and another thermoplastic polymer.

20. The composition as claimed in claim 19, wherein the thermoplastic polymer is a polyolefin.

21. The composition as claimed in claim 19, wherein the ratio (by weight) of the ethylene copolymer to the thermoplastic polymer is in the range of 0.01/99.99 to 99.99/0.01.

22. A molded product comprising the ethylene copolymer composition of claim 19.

ABSTRACT

The ethylene copolymer of the invention is a copolymer (A-1) of ethylene and an α-olefin of 3 to 20 carbon atoms and has the following properties:

(a) the melt index (MI2) at 190°C under a load of 2.16 kg is in the range of 0.0001 to 1000 g/10 min,

(b) the density is not more than 0.899 g/cm^3,

(c) the relationship between a vinyl group amount and MI2 of the polymer satisfies the following expression (c):

(vinyl group amount: number of vinyl groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (c),

and

(d) the relationship between a vinylidene group amount and MI2 of the polymer satisfies the following expression (d):

(vinylidene group amount: number of vinylidene groups/1000 carbon atoms) ≤ 0.018038+0.003259×log(MI2) (d).

The ethylene copolymer has a melt index, a density, a vinyl group amount and a vinylidene group amount in the specific ranges, and hence the copolymer is excellent in mechanical properties, molding processability, heat stability in the molding process and heat aging resistance. The ethylene copolymer of the invention can be used for various molded

products, particularly films and sheets, resin modifiers, and elastomeric products.